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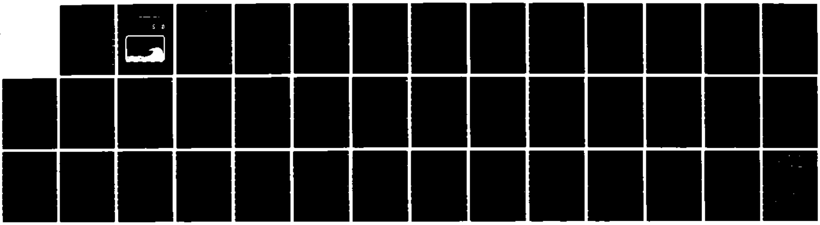

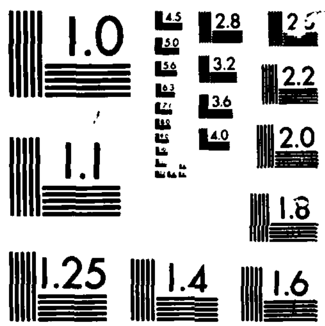

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US Army Corps
of Engineers
Los Angeles District

COAST OF CALIFORNIA
STORM AND TIDAL WAVES STUDY

HYDRAULIC DATA INVENTORY

SOUTHERN CALIFORNIA COASTAL ZONE

CCSTWS 85-9
December 1985

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

THIS REPORT IS A LITERATURE REVIEW AND DATA SUMMARY COVERING THE TOPICS OF RIVER SEDIMENT DISCHARGE, LAGOON STORAGE, STREAMBED SEDIMENT, AND WIND TRANSPORT. THIS LITERATURE REVIEW AND DATA SUMMARY ARE LIMITED TO CALIFORNIA COASTAL RIVERS/STREAMS BETWEEN RAGGED POINT (SAN LUIS OBISPO COUNTY) AND THE MEXICAN BORDER AND ARE LIMITED TO LITERATURE CONTAINING MEASUREMENTS OR QUANTITATIVE ESTIMATES PERTAINING TO THE ABOVE TOPICS.

A SUMMARY OF RESULTS IS AS FOLLOWS. TWENTY-THREE REFERENCES WERE LOCATED WHICH CONTAIN QUANTITATIVE INFORMATION ON RIVER SEDIMENT DISCHARGE. PRACTICALLY-

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NO QUANTITATIVE INFORMATION ON LAGOON SEDIMENT STORAGE FOR SOUTHERN CALIFORNIA WAS LOCATED DURING THIS REVIEW. SEVEN REFERENCES WERE LOCATED WHICH CONTAIN RESULTS OF SEDIMENT GRADATION TESTS OF STREAMBED SAMPLES. THESE REFERENCES GIVE DATA FOR 11 SOUTHERN CALIFORNIA STREAMS. NO QUANTITIVE INFORMATION ON WIND TRANSPORT OF SEDIMENT WAS LOCATED FOR THE SOUTHERN CALIFORNIA COAST. SOME INFORMATION CONCERNING COASTAL SAND DUNE LOCATIONS IN ONE REFERENCE AND SOME CONCERNING WIND DIRECTION IN ANOTHER REFERENCE WHCIH MAY BE USEFUL FOR ESTIMATING WIND TRANSPORT IN FUTURE ANALYSES.

HYDRAULIC DATA INVENTORY
SOUTHERN CALIFORNIA COASTAL ZONE
RAGGED POINT (SAN LUIS OBISPO COUNTY) TO MEXICAN BORDER

Ref. No. CCSTWS 85-9

Coast of California Storm and Tidal Waves Study

U.S. Army Corps of Engineers
Los Angeles District, Planning Division
Coastal Resources Branch
P.O. Box 2711
Los Angeles, California 90053

DECEMBER 1985

COAST OF CALIFORNIA STORM AND TIDAL WAVES STUDY

Hydraulic Section Data Summary

1. INTRODUCTION

a. Topics. In October 1984, Hydraulics Section was requested to conduct the Coast of California Storm and Tidal Waves Study Expansion Program. Part of this request was that a literature review shall be conducted. Specifically, it was determined that Hydraulics Section would be responsible for the topics of: river sediment discharge, lagoon storage, streambed sediment, and wind transport.

It was requested that the information found in the literature review be presented in three data summary reports, one for each of three coastal regions: San Diego, South Coast, and South Central.

b. Limitations. The literature review and data summary are limited to California coastal streams between Ragged Point and the Mexican Border, and are strictly limited to literature containing measurements or quantitative estimates pertaining to the above topics.

2. PROCEDURE The literature review was conducted in the following manner.

First, a survey was made of all the material available in the Hydraulics Section.

Second, a survey was made of all the material available in the Los Angeles District Corps Library.

Third, a computer search was made with the help of the Los Angeles District Librarian. The search was conducted using the NTIS and Engineering Index computer data bases, with the assigned and related topics as keywords. Pertinent material found by this process was ordered by the librarian.

Fourth, any publication lists that could be located were reviewed, among them lists from the U.S. Geological Survey, the Environmental Quality Laboratory of the California Institute of Technology, and the Corps of Engineers Coastal Engineering Research Center. Pertinent publications were located.

Fifth, the bibliographies and reference lists within all the material collected were reviewed and pertinent material was located.

Sixth, visits were made to the Los Angeles City Library and to the California State University at Long Beach Library. In addition to reviewing the collections at these locations, a review was also made of the card catalogs of the Scripps Institute of Oceanography, the University of California at Los Angeles and at Berkeley, and the U.S. Geological Survey Library.

Seventh, personnel from each of the county flood control agencies having jurisdiction over some part of the coast within the area being reviewed was contacted, either by letter, by telephone, or in person to see if they might have, or know of any pertinent information.

As a result of this review, 36 references were located. These references came from many different sources, among them were: The Environmental Quality Laboratory at the California Institute of Technology, the State of California Department of Water Resources, the U.S. Geological Survey, Simons, Li and

Associates, the Corps of Engineers Los Angeles District, the Soil Conservation Service, the Corps of Engineers Waterways Experiment Station and Coastal Engineering Research Center, the U.S. Forest Service, and the American Society of Civil Engineers.

3. RIVER SEDIMENT DISCHARGE AND LAGOON STORAGE

a. Lagoon Storage. River sediment discharge and lagoon storage are related topics. Some of the rivers on the California coast have lagoons at their mouths. These lagoons store sediment delivered by the rivers until a relatively large flood event breaches the barrier between the lagoon and the ocean and flushes the stored sediment into the ocean.

Unfortunately, practically no quantitative information on lagoon sediment storage for Southern California was located during this review.

b. River Sediment Discharge. Twenty-three references were located which contained quantitative information on river sediment discharge. Three types of information were collected: average annual sediment delivery to the ocean, the presence or absence of a sediment versus water discharge rating curve, and the presence or absence of a sediment transport computer model of the stream.

The average annual discharge values were all converted to metric tonnes per year for purposes of comparison. The following relations were used for conversion: 0.9072 tonnes/ton, 1.6 tonnes/meter^3, and 0.764555 meter^3/cubic yard^3.

As requested in the Scope of Work the results are presented in three separate tables, one for each of the three southern California regions. See Tables 1, 2, and 3.

4. STREAMBED SEDIMENT. Seven references were located which contained the results of sediment gradation tests of streambed samples. All together information was located for eleven southern California coastal streams. The results are presented in tables 4, 5, and 6.

5. WIND TRANSPORT No quantitative information on wind transport of sediment along the California coast was located in the literature search.

Some information concerning coastal sand dune locations (Ref. 33), and concerning wind direction (Ref. 9) was located. This information may be useful for estimating wind transport to the ocean in future analyses.

6. DATA QUALITY.

a. General. Because river sediment discharge was the only topic for which quantitative data was obtained, the following discussion pertains to that topic only. The quality of the data collected in this literature search may be classified as first and second order. First order of quality data for river sediment discharge is derived, at least partly, from suspended sediment measurements made on a stream. For almost all cases in this literature search, these measurements were made by the U.S. Geological Survey with sediment gages. Second order of quality data consists of the application of some sort of sediment transport relation or logical computation procedure to other kinds of measurements such as streambed sediment gradations, delta surveys, channel geometry, fire history, vegetation, streamgage records, etc... in order to estimate average annual sediment discharge.

Five references contained first order of quality data. They are: number 4 (Brownlie, 1981), number 16 (Kroll, 1975), number 17 (Kroll, 1969) number 18 (Rodolfo, 1970), and number 35 (Williams, 1979). Fifteen references contain second order of quality data. They are: number 3 (Boyle, 1982), number 5 (Calif. 1969), number 7 (Chang, 1975), number 12 (Handin, 1951), number 14 (Johnson, 1963), number 15 (Johnson, 1959), number 19 (Ryono, 1977), number 21 (Simons, Li, and Assoc., 1983), number 22 (Simons, Li, and Assoc., 1984), number 24 (Steffen, 1984), number 25 (Taylor, 1981), number 27 (Corps, 1952), number 28 (Corps, 1962), number 32 (Corps, 1984), and number 34 (Watts, 1963).

Caution must be taken in comparing the values obtained from different references for any given stream, as different references often supplied estimates of different kinds of average annual sediment discharge. Some estimate the total sediment discharge, some the sand discharge, some the material coarser than 0.062 mm, and some the discharge of material present in the streambed only.

The following discussion addresses the quality and type of estimates available on a stream by stream basis.

b. Tijuana River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 162,000 tonnes/year for the total sediment load. The quality is partly first order and partly second order. The suspended sediment part of the load estimate is

based on measurements at a sediment gage. The unsampled part of the total sediment load is estimated with the modified Einstein method.

(2) Reference 5 (Calif. 1969) estimates 906,700 cubic yards/year (cy/yr) of sediment with particle sizes between 0.062 mm and 8.0 mm. This converts to 1,109,155 tonnes/year with the relations .764555 cubic meters/cy and 1.6 tonnes/cubic meter for purposes of comparison. This is a second order of quality estimate based on the modified Einstein method.

c. Otay River. No reference was found which pertained specifically to the Otay River. Reference 25 (Taylor, 1981), however, contains an estimate for the Sweetwater and Otay Basins combined. The estimate of 282,000 cubic meters/year is for total sediment load. This was converted to 451,000 tonnes/year with the relation 1.6 tonnes/cubic meter. This data is of second order of quality. It was obtained through the application of a statistical model developed through the analysis of data on sediment catchments primarily in the upper watersheds in Southern California.

d. Sweetwater River.

(1) See item 6c.

(2) Reference 32 (Corps, 1984) gives an estimate of 12,000 tons/year reaching the existing mouth of the Sweetwater River. This estimate was taken from reference 19 (Ryono, 1977). This was converted to 10,890 tonnes/year for purposes of comparison to other values.

(3) Reference 19 (Ryono, 1977) gives an estimate of 12,090 tons/yr for total sediment yield. This must be increased by 60 percent to account for fires. The published estimate converts to 17,549 tonnes/year. Flaxman's method was used to obtain the estimate. The estimate is of second order of quality.

e. San Diego River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 25,300 tonnes/year for total sediment load. The data quality is the same as that in item 6.b.(1).

(2) Reference 19 (Ryono, 1977) gives an estimate of 52,860 tons/yr for total sediment yield. This must be increased by 78 percent to account for fires. This was converted to 85,859 tonnes/year. The data quality is the same as that in item 6.d.(3).

f. Los Penasquitos Creek. No reference was found which pertains specifically to Los Penasquitos Creek. Reference 25 (Taylor, 1981), however, contains an estimate for the San Clemente Canyon Group which includes Los Penasquitos Creek. The estimate of 42,700 cubic meters/year is for total sediment load. This converts to 68,320 tonnes/year. The data quality is the same as that in item 6.c.

g. San Dieguito River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 15,300 tonnes/year for total sediment load. This estimate is based on a reservoir survey of Lake Hodges and is of second order of quality.

(2) Reference 7 (Chang, 1975) gives an estimate of 67,200 cy/yr for sand influx to the ocean from the San Dieguito River. This converts to 82,205 tonnes/year. This estimate is of second order of quality and is based on the DELTA computer program, the concept of the density probability function, channel geometry, sediment properties at the river mouth, and various frequency flood hydrographs.

(3) Reference 19 (Ryono, 1977) gives an estimate of 11,970 tons/yr for total sediment load. This must be increased by 60 percent to account for fires. This was converted to 17,375 tonnes/year. The data quality is the same as that in item 6.d.(3).

h. Escondido Creek.

(1) Reference 19 (Ryono, 1977) contains an estimate of 47,680 tons/yr. for total sediment load. This must be increased by 30 percent to account for fires. The published estimate converts to 56,232 tonnes/year. The data quality is the same as that in item 6.d.(3).

(2) Reference 25 (Taylor, 1981) contains an estimate for total sediment discharge for the Escondido Creek Group which includes Escondido Creek and Loma Alta Creek. The published estimate of 129,100 cubic meters/year converts to 206,500 tonnes/year. The data quality is the same as that in item 6.c.

i. Loma Alta Creek. See item 6.h.(2).

j. San Luis Rey River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 67,700 tonnes/year for the total sediment load. The data quality is the same as that in item 6.b.(1).

(2) Reference 5 (Calif., 1969) gives an estimate of 341,500 cy/yr for particle sizes between 0.062 mm and 8.0 mm. This converts to 429,986 tonnes/year. The data quality is the same as that in item 6.b.(2).

k. Santa Margarita River.

(1) Reference 4 (Brownlie, 1981) contains an estimate of 43,500 tonnes/year for the total sediment load. The data quality is the same as that in item 6.b.(1).

(2) Reference 5 (Calif., 1969) contains an estimate of 14,800 cy/yr for particle sizes between 0.062 mm and 8.0 mm. This converts to 18,105 tonnes/year. See item 6.b.(2) for a discussion of data quality.

l. Las Flores Creek. No reference was found which pertained specifically to Las Flores Creek. Reference 25 (Taylor, 1981), however, contains an estimate for the Laguna Hills Group which includes Las Flores Creek, San Juan Creek, Aliso Creek, and San Diego Creek. The published estimate of 564,700 cubic meters/year was converted to 903,520 tonnes/year. This estimate is for total sediment load. The data quality is the same as that in item 6.c.

m. San Juan Creek.

(1) Reference 5 (Calif., 1969) contains an estimate of 46,800 cy/yr for particle diameters between 0.062 mm and 8.0 mm. This converts to 57,250 tonnes/year. The data quality is the same as that in item 6.b.(2).

(2) Reference 17 (Kroll, 1969) contains an estimate of 234 tons/day for total sediment load. This estimate converts to 77,484 tonnes/year. The quality of the estimate is partly first order and partly second order. The estimate was based on the USGS flow-duration method using a sediment rating curve. This curve was developed partly from measured sediment discharge data and partly from an estimate of the unmeasured sediment load using the modified Einstein procedure.

(3) Reference 22 (Simons, Li, and Assoc., 1984) contains an estimate of 84,000 tons/yr of sediment larger than 0.1 mm delivered to the beach. This converts to 76,931 tonnes/year. This estimate is of second order of quality. It was made using the Meyer-Peter Muller equation for bed load and the Einstein integral for suspended load.

(4) See item 6.1.

n. Aliso Creek. No reference was found which pertains specifically to Aliso Creek. Reference 25 (Taylor, 1981) contains an estimate for the Laguna Hills Group which includes Aliso Creek. See item 6.1.

o. San Diego Creek.

(1) See item 6.1.

(2) Reference 3 (Boyle, 1982) contains an estimate of 85,500 tons/year of total sediment reaching upper Newport Bay. This converts to 77,566 tonnes/year. The estimate is of second order of quality, but was checked against USGS gaged data. The bedload was estimated by the Meyer-Peter Muller equation and suspended load was estimated by a "procedure similar to Einstein's".

p. Santa Ana River.

(1) Reference 4 (Brownlie, 1981) contains an estimate of 140,000 cubic meters/year of sand. This converts to 224,000 tonnes/year. This estimate is based on an interpretation of the information published in reference 15 (Kroll, 1975). See item 6.p.(3) for a discussion of the data quality in reference 15.

(2) Reference 5 (Calif., 1969) contains an estimate of 29,200 cy/yr of sediment particles between 0.062 mm and 8.0 mm in diameter. This converts to 35,720 tonnes/year. The data quality is the same as that in item 6.b.(2).

(3) Reference 16 (Kroll, 1975) gives an estimate of 1500 tons/day of coarse sediment discharge. This converts to 496,692 tonnes/year. The quality of the estimate is partly first order and partly second order. The estimate was based on the USGS flow duration method using a sediment rating curve. The curve was developed partly from measured sediment discharge data and partly from an estimate of the unmeasured sediment load using the modified Einstein procedure.

(4) Reference 18 (Rodolfo, 1970) contains an estimate of 717,000 metric tonnes/year of total suspended sediment load for the Santa Ana, San Gabriel, and Los Angeles Rivers combined. This data is first order of quality based upon independent suspended sediment measurements.

q. San Gabriel River.

(1) No reference was found which pertains specifically to the San Gabriel River. Reference 4 (Brownlie, 1981), however, contains an estimate for the San Gabriel and Los Angeles Rivers combined. The original published estimate

of 200,000 cubic meters/year converts to 320,000 tonnes/ year. This is based upon delta surveys and a comparison of the 1938 and 1969 storm sediment deliveries on the Los Angeles River. This estimate is of second order of quality.

(1) See item 6.p.4.

r. Los Angeles River.

(1) No reference was found which pertains specifically to the Los Angeles River. See item 6.q.

(2) See item 6.p.4

s. Ballona Creek. No reference was found which pertains specifically to Ballona Creek. Reference 25 (Taylor, 1981), however, contains an estimate for the Santa Monica Mountains Group which includes Ballona Creek, Topanga Creek, and Malibu Creek. The original published estimate of 279,100 cubic meters/years converts to 446,560 tonnes/year. The data quality is the same as that in item 6.c.

t. Topanga Creek.

(1) No reference was found which pertains specifically to Topanga Creek. Reference 12 (Handin, 1951) contains an estimate of 2550 cy/square mile/year of sand for the area between Point Mugu and Santa Monica. This estimate is based on reservoir sediment surveys of Rindge Reservoir on Malibu Creek. This area between Point Mugu and Santa Monica contains Topanga Creek and Malibu Creek. This reference estimates 60.6 square miles of sand

producing drainage area between these two points. The value of 189,035 tonnes/year was obtained by multiplying 2550 by 60.6 and converting the units.

(2) See item 6.s.

u. Malibu Creek.

(1) Reference 12 (Handin, 1951) indicates that no sediment will reach the ocean from Malibu Creek. This is based on the observation that there are five reservoirs in the Malibu Creek watershed.

(2) See item 6.s.

v. Calleguas Creek.

(1) Reference 4 (Brownlie, 1981) provides an estimate of 260,000 tonnes/year of total sediment load. The data quality is the same as that in item 6.b.(1).

(2) Reference 24 (Steffen, 1982) provides an estimate of 94,000 tons/year of total sediment load. This converts to 85,277 tonnes/year. The estimate is of second order of quality. This estimate is based on the area under the sediment yield versus probability curve. The estimates of sediment yields for various frequency floods were determined by comparing the peak of each flood to the peak of the 1969 flood and applying the ratio to the 1969 flood sediment yield.

(3) Reference 12 (Handin, 1951) estimates that Calleguas Creek contributes little or no beach building material. This is based on the observations that (1) there is negligible run-off to the ocean, (2) the sedimentation rate in the basin is low, (3) Laguna Mugu would trap the

sediment first, (4) petrographic studies indicate that sand from this watershed is not added to the beaches, (5) the median grain size in the streambed is much smaller than that on adjacent beaches, and (6) hydrographic charts indicate little change in the shoreline off Laguna Mugu over time.

w. Santa Clara River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 3,330,000 tonnes/year of total sediment load. The data quality is the same as that in item 6.b.(1).

(2) Reference 35 (Williams, 1979) gives an estimate of 3,550,000 tons/year of total sediment discharge. This converts to 3,220,560 tonnes/year. The estimate is partly first order of quality and partly second order of quality. A sediment rating curve was developed partly based on USGS suspended sediment data and partly based on the modified Einstein procedure to account for the unsampled load. This rating curve was applied to the water discharge gage record from 1950 to 1975 to estimate the average annual sediment discharge.

(3) Reference 21 (Simons, Li and Assoc., 1983) estimates that the average annual sediment discharge is 200,000 tons/year for medium sand and coarser material. This converts to 181,400 tonnes/year. This data is partly first order and partly second order of quality. It is based on sediment discharge rating curves which are derived partly from suspended sediment data gaged by the USGS and partly from the modified Einstein and the Meyer-Peter Muller procedure.

(4) Reference 12 (Handin, 1951) gives an estimate of 1,400,000 cubic yards/year of sand. This converts to 1,712,603 tonnes/year. This data is second order of quality based upon sedimentation rates supplied by the California Forrest and Range Experiment Station. These rates were based on measurements made in the San Gabriel and San Bernardino Mountains.

(5) Reference 34 (Watts, 1963) estimates that 611,000 cubic yards/year of sand is delivered to the coast by the Santa Clara River. This converts to 747,429 tonnes/year. This data is second order of quality. This information was taken from "Special Interim Report on the Ventura Area", Beach Erosion Control Report, U.S. Army Engineer District, Los Angeles, California, August 1961.

(6) Reference 28 (Corps, 1962) contains an estimate of 1,060,000 cubic yards/year for sand discharge to the beaches. This converts to 1,296,685 tonnes/year. This is based upon sedimentation rates supplied by the California Forest and Range Experiment Station, USDA, for the watershed and the estimate that 50 percent will reach the ocean. This is second order of quality data.

(7) Reference 27 (Corps, 1952) contains an estimate of 1,400,000 cubic yards/year for sand discharge to the beaches. This converts to 1,712,603 tonnes/year. This is based upon sedimentation rates supplied by the California Forest and Range Experiment Station, USDA and the estimate that 50 percent will reach the ocean. This is second order of quality data.

x. Ventura River.

(1) Reference 4 (Brownlie, 1981) gives an estimate of 439,000 tonnes/year of total sediment discharge. The data quality is the same as that found in item 6.b.(1).

(2) Reference 5 (Calif., 1969) gives an estimate of 100,100 cubic yards/year of sediment with particle diameters between 0.062 mm and 8.0 mm. This converts to 122,451 tonnes/year. The data quality is the same as that found in item 6.b.(2).

(3) Reference 12 (Handin, 1951) gives an estimate of 300,000 cubic yards/year of sand delivered to the coast. This converts to 366,986 tonnes/year. The data quality is the same as that found in item 6.w.(4).

(4) Reference 34, (Watts, 1963) gives an estimate of 105,000 cubic yards of sand delivered to the coast. This converts to 128,445 tonnes/year. The data quality is the same as that found in item 6.w.(5).

(5) Reference 28 (Corps, 1962) contains an estimate of 150,000 cubic yards/year of sand discharge to the beaches. This converts to 183,493 tonnes/year. The data quality is the same as that for item 6.w.(6).

(6) Reference 27 (Corps, 1952) contains an estimate of 300,000 cubic yards/year of sand discharge to the beaches. This converts to 366,986 tonnes/year. The data quality is the same as that for item 6.w.(7).

y. Carpinteria Creek.

(1) No reference was found which pertains specifically to Carpinteria Creek. Reference 25 (Taylor, 1981), however contains an estimate for the Santa Ynez Mountains Group which includes Carpinteria Creek, Franklin Creek, Mission Creek, Arroyo Burro Creek, San Jose Creek, Gaviota Creek, and Jalama Creek. The published estimate of 662,100 cubic meters/year converts to 1,059,360 tonnes/year. The data quality is the same as that found in item 6.c.

(2) Reference 12 (Handin, 1951) includes an estimate for the area between Sand Point and the Ventura River which includes Carpinteria Creek and Franklin Creek. The original published estimate of 195 cy/day converts to 87,068 tonnes/year. This estimate is second order of quality. It is based on an estimate of the sand delivered from the area between Point Concepcion and Santa Barbara Harbor, and a ratio of the drainage areas.

(3) Reference 27 (Corps 1952) contains an estimate for the area between Sand Point and the Ventura River of 30,000 cubic yards/year. This area includes Carpinteria and Franklin Creeks. The estimate is for sand discharge and is based on a sedimentation rate derived from an analysis of Rindge Reservoir on Malibu Creek. This sedimentation rate was applied to areas of the drainage basins containing sand producing rock. This data is of second order of quality.

z. Franklin Creek.

(1) See item 6.y.(1).

(2) See item 6.y.(2).

(3) See item 6.y.(3).

aa. Mission Creek.

(1) See item 6.y.(1).

(2) Reference 12 (Handin, 1951) contains an estimate for the area between Santa Barbara and Point Concepcion which includes Mission Creek, Arroyo Burro Creek, San Jose Creek, and Gaviota Creek. The published estimate of 775 cy/day converts to 346,038 tonnes/year. This estimate is second order of quality and is based on beach erosion studies conducted by the Beach Erosion Board in 1938, and by the Los Angeles District Corps of Engineers in 1946.

bb. Arroyo Burro Creek.

(1) See item 6.y.(1).

(2) See item 6.aa.(2).

cc. San Jose Creek.

(1) See item 6.y.(1).

(2) See item 6.aa.(2).

dd. Gaviota Creek.

(1) See item 6.y.(1).

(2) See item 6.aa.(2)

ee. Jalama Creek. See item 6.y.(1).

ff. San Ynez River.

(1) Reference 5 (Calif., 1969) gives an estimate of 9000 cubic yards/year of sediment with particle diameters between 0.062 mm and 8.0 mm. This converts to 11,010 tonnes/year. The data quality is the same as that found in item 6.b.(2).

(2) Reference 15 (Johnson, 1959) contains an estimate of 770,000 tons/year of sediment coarser than 80 mesh (very fine sand). This converts to 698,544 tonnes/year. This estimate is second order of quality based on the Einstein method.

gg. San Antonio Creek. No estimate was located for San Antonio Creek.

hh. Santa Maria River.

(1) Reference 5 (Calif., 1969) contains an estimate of 93,600 cubic yards/year of sediment with particle diameter between 0.062 mm and 8.0 mm. This converts to 114,500 tonnes/year. The data quality is the same as that found in item 6.b.(2).

(2) Reference 16 (Kroll, 1975) contains an estimate of 1700 tons/day of total sediment discharge. This converts to 562,918 tonnes/year. This estimate is partly first order and partly second order of quality. A rating curve was developed based partly on USGS suspended sediment gage measurements and partly on the modified Einstein procedure. The USGS flow-duration procedure was then used to estimate average mean daily discharge.

(3) Reference 15 (Johnson, 1959) contains an estimate of 240,000 tons/year of sediment coarser than 80 mesh (very find sand). This converts to 217,728 tonnes/year. The data quality is the same as that found in item 6.ff.(2).

ii. Arroyo Grande. Reference 5 (Calif., 1969) contains an estimate of 9100 cy/yr of sediment with particle diameters between 0.062 mm and 8.0 m. This converts to 11,132 tonnes/year. The data quality is the same as that found in item 6.b.(2).

jj. Pismo Creek. No estimate was found for Pismo Creek.

kk. San Luis Obispo Creek. No estimate was found for San Luis Obispo Creek.

ll. Morro Creek. No estimate was found for Morro Creek.

mm. Toro Creek. No estimate was found for Toro Creek.

nn. Villa Creek. No estimate was found for Villa Creek.

oo. Santa Rosa Creek. No estimate was found for Santa Rosa Creek.

pp. Arroyo del la Cruz. Reference 5 (Calif., 1969) contains an estimate of 3400 cy/yr for sediment with particle diameters between 0.062 mm and 8.0 mm. This converts to 4159 tonnes/year. The data quality is the same as that found in item 6.b.(2).

Table 1. San Diego Region

Average Annual Sediment Delivery to the Coast in Metric Tonnes per Year

Stream	Littoral Cell	Reference Number						
		4	25	5	32	30	7	19
Tijuana	Silver Strand	162,000*		1,109,155*				
Otay River	Silver Strand							
			451,200*					
Sweetwater River	Silver Strand				10,890**			17,549
San Diego River	Mission Bay	25,300*						85,359
Los Penasquitos Cr.	Oceanside		68,320*					
San Dieguito River	Oceanside	15,300*					82,205	17,375
Escondido Cr.	Oceanside							56,232
			206,560*					
Loma Alta Cr.	Oceanside							
San Luis Rey River	Oceanside	67,700*		429,986*		**		
Santa Margarita R.	Oceanside	43,500*		18,105*				
Las Flores Cr.	Oceanside	See S. Coast Region						

*sediment rating curve

**computer model

Table 2. South Coast Region

Average Annual Sediment Deliver to the Coast in Metric Tonnes Per Year

Stream	Littoral Cell	Reference Number								
		4	25	5	17	16	12	22	3	18
San Juan Cr.	Oceanside		Includes Las Flores Cr. 903,520*	57,250*	77,484*			76,931**		
Aliso Cr.	S. San Pedro Rch.									
San Diego Cr.	San Pedro								77,566	
Santa Ana River	San Pedro	224,000		35,720*		496,692*				
San Gabriel R.	San Pedro									
		320,000								717,000
Los Angeles R.	San Pedro									
Ballona Cr.	Santa Monica									
Topanga Cr.	Santa Monica		446,560*				189,035			
Malibu Cr.	Santa Monica						0			

*sediment rating curve

**computer model

Table 3. South Central Region

Average Annual Sediment Delivery to the Coast in Metric Tonnes Per Year

Stream	Littoral Cell	Reference Number											
		4	25	5	35	21	16	24	12	15	34	28	27
Calleguas Cr.	Santa Barbara	260,000*						85,277	0				
Santa Clara River	Santa Barbara	3,330,000*			3,220,560*	181,440***			1,712,603		747,429	1,296,685	1,712,603
Ventura River	Santa Barbara	439,000*		122,451*					366,986		128,445	183,493	366,986
Carpinteria Cr.	Santa Barbara								87,068				36,698
Franklin Cr.	Santa Barbara												
Mission Cr.	Santa Barbara												
			1,059,360*										
Arroyo Burro Cr.	Santa Barbara								346,038				
San Jose Cr.	Santa Barbara												
Gaviota Cr.	Santa Barbara												
Jalama Cr.	Santa Barbara												
Santa Ynez R.	Santa Ynez			11,010*						698,544*			
San Antonio Cr.	Santa Ynez												
Santa Maria River	Santa Maria			114,500*			562,918*			217,728*			
Arroyo Grande	Santa Maria			11,132*									

*sediment rating curve
**computer model
***sediment rating curve and computer model

Table 3 (Continued)

Stream	Littoral Cell	Reference Number 4	25	5	35	21	16	24	12	15
Pismo Cr.	Santa Maria									
San Luis Obispo Cr.	S. Morro Bay Rch.									
Morro Cr.	Morro Bay									
Toro Cr.	Morro Bay									
Villa Cr.	Morro Bay									
Santa Rosa Cr.	Morro Bay									
Arroyo de la Cruz	Morro Bay			4159						

*sediment rating curve

**computer model

Table 4. San Diego Region

Location of Streambed Gradation Information

Stream	Littoral Cell	Reference Number						
		4	21	29	16	22	20	23
Tijuana River	Silver Strand	X						
Otay River	Silver Strand							
Sweetwater River	Silver Strand							
San Diego River	Mission Bay	X						
Los Penasquitos Cr.	Oceanside							
San Dieguito River	Oceanside							
Escondido Cr.	Oceanside							
Loma Alta Cr.	Oceanside							
San Luis Rey River	Oceanside	X		X				
Santa Margarita R.	Oceanside	X						
Las Flores Cr.	Oceanside							

Table 5. South Coast Region

Location of Streambed Gradation Information

Stream	Littoral Cell	Reference Number						
		4	21	29	16	22	20	23
San Juan Creek	Oceanside					X		
Aliso Creek	S. Pedro Rch.							
San Diego Creek	San Pedro							
Santa Ana River	San Pedro				X			
San Gabriel River	San Pedro							
Los Angeles River	San Pedro							
Ballona Creek	Santa Monica							
Topanga Creek	Santa Monica							
Malibu Creek	Santa Monica							

Table 6. South Central Region

Location of Streambed Gradation Information

Stream	Littoral Cell	Reference Number						
		4	21	29	16	22	20	23
Calleguas Creek	Santa Barbara	X						X
Santa Clara River	Santa Barbara	X	X					
Ventura River	Santa Barbara	X						
Carpinteria Creek	Santa Barbara							
Franklin Creek	Santa Barbara							
Mission Creek	Santa Barbara						X	
Arroyo Burro Creek	Santa Barbara							
San Jose Creek	Santa Barbara							
Gaviota Creek	Santa Barbara							
Jalama Creek	Santa Barbara							
Santa Ynez River	Santa Ynez							
San Antonio Creek	Santa Ynez							
Santa Maria river	Santa Maria				X			
Arroyo Grande	Santa Maria							
Pismo Creek	Santa Maria							

Table 6 (Continued)

Stream	Littoral Cell	Reference Number						
		4	21	29	16	22	20	23
San Luis Obispo Cr.	S. Morro Bay Rch.							
Morro Creek	Morro Bay							
Toro Creek	Morro Bay							
Villa Creek	Morro Bay							
Santa Rosa Creek	Morro Bay							
Arroyo de la Cruz	Morro Bay							

7. REFERENCES

1. Brooks, N. H., Storms, Floods, and Debris Flows in Southern California and Arizona, 1978 and 1980: Overview and Summary of a Symposium, September 17-18, 1980. Committee on Natural Disasters, National Research Council, Environmental Quality Laboratory, California Institute of Technology, National Academy Press, Washington D. C., May 1982, 487 pages.

2. Brownlie, W., Brown, W.M., Effect of Dams on Beach Sand Supply: Coastal Zone '78, Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management, San Francisco, California, ASCE, Volume 3, March 1978, pages 2273-2287.

3. Boyle Engineering Corporation, Sediment Source Analysis and Sediment Delivery Analysis, Newport Bay Watershed, San Diego Creek, Comprehensive Stormwater Sedimentation Control Plan: San Diego, California, October, 1982, 48 pages.

4 Brownlie, W. R., and Taylor, B. D., Coastal Sediment Delivery by Major Rivers in Southern California: Environmental Quality Laboratory, California Institute of Technology, Pasadena, California, EQL Report Number 17-C, February 1981, 314 pages.

5. California Department of Water Resources, Interim Report on Study of Beach Nourishment along the Southern California Coastline: July 1969, 59 pages.

6. Chang, H.H., Flood Plain Sedimentation and Erosion, Phase IV: County of San Diego, Department of Sanitation and Flood Control, July 1974, 77 pages.

7. Chang, H. H., Flood Plain Sedimentation and Erosion, Phase V: County of San Diego, Department of Sanitation and Flood Control, July 1975. 87 pages.

8. Chang, H.H., Flood Plain Sedimentation and Erosion, Phase VI: County of San Diego, Department of Sanitation and Flood Control, July 1975. 78 pages.

9. Chang, H.H., Modeling of River Channel Changes: ASCE Journal of Hydraulic Engineering, Volume 110, No. 2, February 1984, pages 157-172.

10. Goodridge, J. D., and Bingham, E. Lt., Wind in California: California Department of Water Resources, Sacramento, California, Bulletin 185, January 1978, 267 pages.

11. Hales, L. Z., Mission Bay, California, Littoral Compartment Study: U.S. Army Corps of Engineers Beach Erosion Board and Coastal Engineering Research Center, Washington, D. C., Technical Memo, No. 22, March 1951.

12. Handin, J. W., The Source, Transportation and Deposition of Beach Sediment in Southern California: U.S. Army Corps of Engineers Beach Erosion Board and Coastal Engineering Research Center, Washington, D. C., Technical Memorandum Number 22, March 1951.

13. Inman, D. L., Report on Beach Study in the Vicinity of Mugu Lagoon, California: U.S. Army Corps of Engineers Beach Erosion Board and Coastal Engineering Research Center, Washington, D. C., Technical Memorandum Number 14, March 1950.

14. Johnson, J. W., Sand Movement on Coastal Dunes: Proceedings of the Federal Inter-Agency Sedimentation Conference, 1963, Miscellaneous Publication No. 970, Agricultural Research Service, USDA, June 1965, pages 747-755.

15. Johnson, J. W., The Supply and Loss of Sand to the Coast: ASCE Journal of Waterways and Harbors, Volume 85, September 1959, pages 227-251.

16. Kroll, C. G., Estimate of Sediment Discharges, Santa Ana River at Santa Ana and Santa Maria River at Guadalupe, California: U. S. Geologic Survey, Water Resources Division, Menlo Park, California, Report Number USGS/WRI 40-74, February 1975, 23 pages.

17. Kroll, C. G., Preliminary Determination of Sediment Discharge, San Juan Drainage Basin, Orange and Riverside Counties: U. S. Geologic Survey, Water Resources Division, Menlo Park, California, December 16, 1969, 28 pages.

18. Rodolfo. K. S., Annual Suspended Sediment Supplied to the California Continental Borderland by the Southern California Watershed: Journal of Sedimentary Petrology, Vol. 40, No. 2, June 1970, pages 666-671.

19. Ryono, T., Kanga, F., and Qazi, I., Erosion and Sedimentation in San Diego County Watersheds: California Department of Water Resources, 1977.

20. Simons, Li, and Associates, Inc., Debris Deposition Study for Without-Project Conditions, Santa Barbara County Streams, Mission Creek/ Rattlesnake Creek, Santa Barbara County: Newport Beach, California, September 16, 1984, 100 pages.

21. Simons, Li and Associates, Inc., Hydraulic Erosion and Sedimentation Study of the Santa Clara River, Ventura County, California: Newport Beach, California, September 1983, 320 pages.

22. Simons, Li and Associates, Inc., San Juan Creek and Trabuco Creek, Facility Nos. L01 and L02, Aggradation/Degradation Study: Orange County Environmental Management Agency, Santa Ana, California, August 1984, 158 pages.

23. Simons, Li and Associates, Inc., Sedimentation and Erosion Study of Calleguas Creek, Ventura County, California, Final and Supplemental Data Reports: Newport Beach, California, July 1984, 104 and 73 pages.

24. Steffen, L. J., Mugu Lagoon and its Tributaries, Geology and Sedimentation: U.S. Department of Agriculture, Soil Conservation Service, Watershed Planning Staff, Davis, California, April 1984, 73 pages.

25. Taylor, B. D., Inland Sediment Movements by Natural Processes: Environmental Quality Laboratory, California Institute of Technology, Pasadena, California, EQL Report Number 17-B, October 1981, 81 pages.

26. Taylor, B. D., Sediment Management for Southern California: Coast Zone '78, and Regulatory Aspects of Coastal Zone Management, San Francisco, California, ASCE, Volume 3, March 1978, pages 2259-2264.

27. U.S. Army Corps of Engineers, Los Angeles District, Appendix I, Coast of California, Carpinteria to Point Mugu, Beach Erosion Control Study: House Document No. 29, 83rd Congress, 1st Session, October 1952, 92 pages.

28. U.S. Army Corps of Engineers, Los Angeles District, Coast of Southern California-Special Interim Report on the Ventura Area, Cooperative Beach Erosion Control Study: House Document No. 458, 87th Congress 2nd Session, June 1962, 80 pages.

29. U.S. Army Corps of Engineers, Los Angeles District, Mission Bay Entrance Channel Dredging, San Diego River and Mission Bay, San Diego County, California Draft Environmetnal Impact Statement: Los Angeles, California, 1972, 15 pages.

30. U.S. Army Engineer District, Los Angeles, San Luis Rey River Channel, Murray Road to Pacific Ocean, San Diego, California, Phase II General Design Memorandum, Appendix C, Sediment Transport: Los Angeles, California, December 1983, 39 pages.

31. U.S. Army Corps of Engineers, Los Angeles District, Report on Engineering Aspects, Floods of January and February 1969, Southern California: Los Angeles, California, 1974, 85 pages.

32. U.S. Army Engineer District, Los Angeles, Sweetwater River Flood Control Improvement, General Design Memorandum Appendix 2 - Hydraulic Design: Los Angeles, California, March 1984, 10 pages, 21 plates.

33. Waananen, A. O., Floods of January and February 1969 in Central and Southern California: U.S. Geological Survey, Menlo Park, California, May 1969, 233 pages.

34. Watts, G.W., Sediment Discharge to the Coast as Related to Shore Processes: U.S. Army Corps of Engineers, Beach Erosion Board, Washington D.C., prepared for the Federal Interagency Sedimentation Conference of the Subcommittee on Sedimentation, ICWR, Jackson, Mississippi, 28 January - 1 February 1963, January 1963, 15 pages.

35. Williams, R. P., Sediment Discharge in the Santa Clara River Basin, Ventura and Los Angeles Counties, California: U.S. Geologic Survey, Water Resources Division, Menlo Park, California, USGS/WRI 79-78, August 1979, 56 pages.

36. Zeller, R. P., A General Reconnaissance of Coastal Dunes of California: U.S. Army Corps of Enginees, Beach Erosion Board and Coastal Engineering Reseach Center, Washington, D. C. Miscellaneous Paper Number 1-62 June 1962, 38 pages.

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